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Progress Report

PREDATOR INTRODUCTIONS IN 1962 FOR CONTROL OF THE BALSAM WOOLLY APHID AND AN EVALUATION OF ESTABLISHED PREDATORS

by

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SUMMARY

In the past 6 years, 22 species of foreign insect predators, representing some 64,000 specimens, have been introduced into the Pacific Northwest for control of the balsam woolly aphid, Chermes piceae Ratz. This paper discusses four aspects of the introduction-colonization program:

1. Introductions in 1962 - Two foreign predators were introduced--Laricobius erichsonii Rosen. and Pullus impexus Muls. These insects, collected in Germany by the U. S. Agricultural Research Service, were liberated in six aphid-infested true fir stands in Oregon. Except for two L. erichsonii liberations, establishment appears likely.

2. Status of Established Predators - Five insect predators from Europe are firmly established in the Pacific Northwest--two beetles, L. erichsonii and P. impexus; and three species of flies, Aphidoletes thompsoni Mohn., Cremifania nigrocellulata Cz., and Leucopis obscura (Hal.). Thus far the most effective predators appear to be L. erichsonii and A. thompsoni. Both species have proved capable of developing large populations and both have spread moderately well. A. thompsoni populations have shown special ability in becoming established and spreading under conditions of low prey density.

3. Recolonization in 1962 - Some limited recolonization attempts on an exploratory basis were tried with L. erichsonii and A. thompsoni. To date, 685 L. erichsonii adults have been collected from established colonies and re-liberated in other areas. Success of the recolonization attempts will not be known until the spring of 1963. A. thompsoni was not liberated in the field, but rearing and collecting techniques for future recolonizations were tested.

4. Miscellaneous - The status of most predators introduced in 1961 was summarized in last year's progress report, but the fate of two species, Chrysopa sp. II and Exochomus lituratus Gorh., had not been determined by the end of the year. In 1962, their stories were completed. The E. lituratus population finally died after 19 months in laboratory rearing, and establishment checks showed no sign of the field-liberated Chrysopa II.

PREDATOR INTRODUCTIONS IN 1962 FOR CONTROL OF THE BALSAM WOOLLY APHID AND AN EVALUATION OF ESTABLISHED PREDATORS

By

R. G. Mitchell

INTRODUCTION

Since 1957, 22 species of foreign insect predators have been introduced into Oregon and Washington for control of the balsam woolly aphid, Chermes (=Adelges) piceae Ratz. This progress report, the sixth annual summary of the introduction-colonization program, describes: (1) Introductions made in 1962, (2) current status of established predators, (3) recolonization efforts in 1962, and (4) results of two introductions in late 1961. Administrative details and methodology of the introduction program are covered in previous reports. 1/

1/ Other reports on the predator introduction program in the Pacific Northwest are:

1. Wright, K. H. and R. G. Mitchell. Progress Report. Colonization in Oregon and Washington of Aphidoletes thompsoni - An European Predator of the Balsam Woolly Aphid. Pacific Northwest Forest and Range Experiment Station. Portland, Oregon. February 1, 1958.

2. Wright, K. H., P. E. Buffam and R. G. Mitchell. Progress Report. Colonization of Foreign Insect Predators in 1958 for Control of the Balsam Woolly Aphid. ibid. March 15, 1959.

3. Buffam, P. E., K. H. Wright and R. G. Mitchell. Progress Report. Predator Introductions in 1959 for Control of the Balsam Woolly Aphid and an Evaluation of Releases to Date. ibid. March 15, 1960.

4. Buffam, P. E. and R. G. Mitchell. Progress Report. Foreign Predator Introductions for the Control of the Balsam Woolly Aphid in the Pacific Northwest; 1957-1960. ibid. May 1, 1961.

5. Mitchell, R. G. and P. E. Buffam. Progress Report. Predator Introductions in 1961 for Control of the Balsam Woolly Aphid and an Evaluation of Established Predators. ibid. May 1962.

PREDATOR INTRODUCTIONS IN 1962

Two predator species from Europe were liberated in the Pacific Northwest in 1962 -- 2,281 adult Laricobius erichsonii Rosen. (Coleoptera: Derodontidae) and 942 adult Pullus impexus Muls. (Coleoptera: Coccinellidae). Both species were collected in Germany by Dr. Karl G. Adlung, a German national working for the European Parasite Laboratory, U. S. Agricultural Research Service (ARS), which is headquartered in Paris, France.

As in the past, the ARS laboratory at Moorestown, New Jersey screened the incoming predators for parasites and other undesirable associates and then transmitted the predators to field stations. Some were sent to the Pacific Northwest Station; others to the Southeastern Station at Asheville, North Carolina. Laricobius and Pullus shipments to Portland, Oregon arrived, via air mail, on May 8 and July 10, respectively. Shipments were then divided into nearly equal lots and the predators liberated in six different areas in Oregon. Table 1 shows the release locations and the number of predators liberated. Specific information on the liberations and the observations that followed are presented in the next two subsections.

Table 1.--Summary of predator liberations in the Pacific Northwest in 1962

Species liberated	Source	Release areas	Number liberated
Laricobius erichsonii (Coleoptera: Derodontidae)	Germany	Mt. Hood, Oreg.	600
		Santiam Pass, Oreg.	600
		Monroe, Oreg.	481
		Twin Lakes, Oreg. (Umpqua N.F.)	600
		Subtotal	2,281
Pullus impexus (Coleoptera: Coccinellidae)	Germany	Sisters, Oreg.	442
		McKenzie Pass, Oreg.	500
		Subtotal	942
		TOTAL	3,223

Laricobius erichsonii Liberations

Mt. Hood, Oregon - 600 adults were liberated May 9 by the author on two aphid-infested subalpine firs (Abies lasiocarpa (Hook.) Nutt.) adjacent to U. S. Route 26, 4.2 miles east of Government Camp. Beetles were liberated in the open (i.e., no cages used). Prey densities were heavy on both trees, 60 to 70 aphids per square inch of bark surface. Weather conditions at the time of release were: temperature, 45° F.; no wind; heavy rain. Elevation of the release area is about 4,000 feet.

Checks throughout June revealed that the aphid population died on one release tree but developed well on the other. On July 2 and 23, Laricobius larvae were abundant on the release tree with live aphid population; none were found on the other tree. Although the insect was not seen thereafter, it is believed that it has a good chance of becoming established.

Santiam Pass, Oregon - 600 adults were liberated May 9 by the author on two aphid-infested subalpine firs adjacent to U. S. Route 20, 1 mile east of the summit. As at Mt. Hood, the beetles were released free; however, small roof-like structures of plastic and heavy paper were attached to the release trees to protect the predators from the elements. Prey densities were heavy on both trees, 40 to 60 aphids per square inch. Weather conditions at the time of release were: temperature, 42°F.; wind, 10 to 15 miles per hour from the west; alternately snowing and raining. Elevation of the release area is about 4,500 feet.

The aphid population subsequently died on one release tree but developed well on the other. Establishment checks in late May and early June suggested that the predator had failed to lay eggs, but a subsequent check, on June 23, revealed sizeable larval populations of L. erichsonii on the good release tree and on an adjacent tree some 50 feet west of the liberation point. It appears that establishment will be achieved in this area.

Monroe, Oregon - 481 adults were liberated May 10 by the writer on one aphid-infested grand fir (Abies grandis (Dougl.) Lindl.) in a farm woodlot adjacent to the northeast corner of Benton-Lane Park. Beetles were liberated without use of cage. Prey density on the release tree was about 20 aphids per square inch. Weather conditions at the time of release were: temperature, 56°F.; no wind; high overcast with intermittent sunshine. Elevation of the release area is about 350 feet. The soil at the base of the release tree was spaded and mixed with vermiculite to increase moisture holding capacity and thereby to encourage higher survival when the predators began pupation.

Establishment checks failed to reveal any sign of L. erichsonii in the 2 months following release, but on July 8 one adult and several cast larval skins of the predator were observed. Nevertheless, the prospect of establishing the predator in this location remains in doubt. Other Laricobius liberations in the Willamette Valley have initially appeared successful but subsequently failed. It is hoped that the early release date and soil conditioning measures will be helpful. Finding an adult after completion of the larval generation was encouraging, suggesting that at least some of the predators passed through the critical pupal stage. Now the question is whether the adults can withstand the summer dry period. If they can, it is believed that subsequent generations will begin spring development early enough to complete the larval and pupal generations before drought conditions become critical.

Twin Lakes, Oregon - 600 adults were liberated May 15 by the writer and J. C. Crates (Timber Management Assistant on the Little River Ranger District) on one aphid-infested subalpine fir adjacent to the Twin Lakes Trail (Sec. 16, T. 27 S., R. 2 E.), 0.5 mile southwest of Twin Lakes Mountain Lookout. The beetles were released free, but under a plastic and paper shelter attached to the tree as at Santiam Pass. Prey density on the release tree was about 50 aphids per square inch. Weather conditions at the time of release were: temperature, 38°F.; wind, 15 to 20 miles per hour from the northwest; snowing. Elevation of the release area is about 5,200 feet.

Several checks in subsequent months revealed that the aphid population on the release tree had died. Sizeable aphid populations remained on two trees some 20 feet away from the release point, but the predator was never seen after it was liberated. It is believed that this colonization attempt failed, probably because of a large amount of predator mortality and unseasonable weather. Foresters in the area stated that snow storms and freezing temperatures dominated the weather until nearly mid June.

Discussion - The Laricobius shipment arrived in Portland about the time significant mortality began to occur in the shipping container. On the day the insects arrived (May 8), an inspection revealed about 2 percent of the beetles dead. The next day, when liberations were made at Mt. Hood and Santiam Pass, mortality averaged about 5 percent. By May 10, at the time of the liberation at Monroe, mortality had increased to 10 percent. The last liberation at Twin Lakes on May 15 revealed mortality close to 50 percent.

Doubtlessly the long period between the time the beetles were received and released contributed to the amount of mortality in the last liberation. Nevertheless, the number of dead beetles was surprisingly large. In the past, Laricobius shipments have been held for long periods without noticeable mortality. Perhaps the insects should have been fed when they arrived in Portland. This is the first time we have received Laricobius without supplemental food in the shipping container.

Pullus impexus Liberations

Sisters, Oregon - 442 adults were liberated July 11 by the writer on one aphid-infested subalpine fir adjacent to the Cache Mountain Lookout Road, 0.3 mile from the junction with the old Santiam Road (Sec. 8, T. 14 S., R. 8 E.). Beetles were liberated in a sleeve cage attached to the main stem of the infested tree. All predators were alive and active. Prey density of the release tree was about 40 aphids per square inch of bark surface. Weather conditions at the time of the release were: temperature, 75°F.; no wind; 70 percent cloud cover (clouds were the forerunner of a thunderstorm that moved in that evening). Elevation of the release area is about 4,500 feet.

The cage was torn from the tree by an animal (probably a deer) sometime between July 26 and August 21. Several adult P. impexus were noted August 21 but none thereafter. Checks for eggs in September and October also failed to reveal signs of the predator. Despite the lack of evidence showing P. impexus survival, it is still too early for conjecture on the success or failure of the colonization attempt.

McKenzie Pass, Oregon - 500 adults were liberated July 12 by the writer on one aphid-infested subalpine fir adjacent to U. S. Highway 126, 1.5 miles west of the road junction to Scott Lake. The beetles were released in a sleeve cage attached to the main stem of the release tree. All predators were alive and active. Prey density on the release tree was about 30 aphids per square inch of bark surface. Weather conditions at the time of the release were: temperature, 68°F.; wind, 2 to 3 miles per hour from the west; 30 percent cloud cover. Elevation of the release area is about 5,000 feet.

The cage was removed from the release tree on August 21. Several P. impexus adults were noted when the cage was removed and also when checks were made in mid and late September. A search in October failed to reveal either eggs or adults. Like the release at Sisters, this colonization attempt needs further observation before speculating on success or failure.

STATUS OF ESTABLISHED PREDATORS

Of the 22 species of predators introduced from Europe, Asia, and Australia (Table 2) since the colonization program began 6 years ago, only five European species can be termed "established": Laricobius erichsonii, Aphidoletes thompsoni, Cremifania nigrocellulata Cz., Leucopis obscura (Hal.), and Pullus impexus. This section discusses current status of the established predators -- i.e., predators which prey on the balsam woolly aphid and which have survived one or more winters in the Pacific Northwest. Because the other 17 introduced species have not been recovered, it is assumed they did not survive.

Table 2.--Foreign insect predators introduced since 1957 for control of the balsam woolly aphid in Oregon and Washington

Species, order, and family	Source	Years released	Number released
Adalia luteopicta Muls. (Coleoptera: Coccinellidae)	India	60	156
Adalia tetraspilota Wse. (Coleoptera: Coccinellidae)	India Pakistan	59, 60, 61	176
Aphidecta obliterata L. (Coleoptera: Coccinellidae)	Sweden Germany	58, 59	1,438
*Ballia diana (Coleoptera: Coccinellidae)	India	61	100
Ballia eucharis Muls. (Coleoptera: Coccinellidae)	Pakistan	59	85
Chilocorus kuwanae Silv. (Coleoptera: Coccinellidae)	Japan	58	135
Exochomus lituratus Gorh. (Coleoptera: Coccinellidae)	Pakistan	60, 61	98
Exochomus uropygialus Muls. (Coleoptera: Coccinellidae)	Pakistan	59, 60	6,682
Harmonia breiti Mader (Coleoptera: Coccinellidae)	India	59, 60	83
Leis dimidiata F. (Coleoptera: Coccinellidae)	India	59	23
*Oenopia sauseti Muls. (Coleoptera: Coccinellidae)	India	60	46
Pullus impexus Muls. (Coleoptera: Coccinellidae)	Germany	60, 62	1,342
Scymnus pumilio (Wse.) (Coleoptera: Coccinellidae)	Australia	59, 60	2,859
Synharmonia conglobata L. (Coleoptera: Coccinellidae)	India	59, 60	127
Laricobius erichsonii Rosen. (Coleoptera: Derodontidae)	Czechoslovakia Germany	58, 59, 62	12,406
Cremifania nigrocellulata Cz. (Diptera: Chamaemyiidae)	Czechoslovakia Germany	58, 59	1,374
Leucopis obscura (Hal.) (Diptera: Chamaemyiidae)	Maine (Europe)	58, 59	2,785
Leucopis sp. (Diptera: Chamaemyiidae)	Pakistan	59	15
Aphidoletes thompsoni Mohn. (Diptera: Itonididae)	Czechoslovakia Germany	57, 58, 59	34,204
*Chrysopa sp. I (Neuroptera: Chrysopidae)	Pakistan	61	43
Chrysopa sp. II (Neuroptera: Chrysopidae)	India	61	421**
*Undetermined Hemerobiidae (Neuroptera)	India	61	10
	Total predators introduced		64,608

* None liberated in the field; maintained in laboratory rearing.
** Number includes 288 eggs.

Laricobius erichsonii (Coleoptera: Derodontidae)

Establishment checks in 1962 revealed *L. erichsonii* firmly established at Willamette Pass, Oregon, and Green River and Cold Water Creek, Washington. The predator was not recovered at other release points. The disappearance of *L. erichsonii* at Black Rock, Oregon was especially disappointing and perplexing -- although the aphid population in the area dropped to very low levels in 1960 and 1961, it never completely disappeared. Now the aphid population is beginning to climb again. This situation dramatizes one of the chief faults of *L. erichsonii* -- the beetle rarely attacks the balsam woolly aphid when the density of the prey population averages less than ten aphids per square inch of bark surface.

Other than the predator's inability to utilize low prey populations and its poor survival in areas with droughty soils, *L. erichsonii* populations appear to be exposed to few limiting factors in the Pacific Northwest. The winters do not seem to effect the insect adversely, no predators have been noted, and rearings of some 550 adults from the three established colonies showed no sign of parasitism.

L. erichsonii continues to spread at an accelerated rate in those areas where it is well established. In the two localities studied most, Willamette Pass and Green River, the maximum radius of spread since release in 1958 was 3,650 feet and 1,550 feet, respectively. Spread from 1961 to 1962 was 2,250 and 910 feet -- the greatest in one year since release. Table 3 shows the radius of dispersal each year since liberation.

Table 3.--Annual radius of *L. erichsonii* dispersal since release in 1958 at Willamette Pass, Oregon and Green River, Washington

Years after release	Radius of dispersal in feet	
	Willamette Pass	Green River
One (1959)	75	?
Two (1960)	850	450
Three (1961)	1,400	640
Four (1962)	3,650	1,550

As in 1961, the 1962 predator effectiveness studies were carred out at Willamette Pass. Originally, eight trees were prepared for evaluation, but extreme fluctuations of spring temperatures killed the aphid populations on five trees. On another tree, the aphid population survived but was reduced to a point unsuitable for evaluation. Results of evaluations on the two remaining trees are summarized in Table 4.

Table 4.--Effectiveness of Laricobius erichsonii in 1962 on two trees at Willamette Pass, Oregon

Evaluation tree	Peak Laricobius population	Peak aphid population in the first generation*	Change in aphid population density from 1st to 2nd generation*	
			Protected population	Exposed population
	No. per ft.^{2}	No. per in.^{2}	Percent	
100	3.2	58	-21.8	-58.1
200	1.2	19	+39.0	-43.6

* Counts of aphid populations do not include neosistentes, a stage not susceptible to predation.

Table 4 shows that Laricobius reduced the exposed aphid populations on both trees. On tree 100, both protected and exposed populations were declining because of reduced tree vigor, but the exposed population dropped at a rate somewhat faster than the protected population. Although this indicates a degree of predation by L. erichsonii, it is of little significance because by the end of the year the tree was damaged to a point well beyond recovery.

Tree 200 demonstrates true control; while the aphid population protected from predation was climbing, the exposed population decreased. It remains to be seen whether the reduction will be enough to save the tree. If possible, the same tree will be used for evaluation in 1963.

A complication in the evaluation of tree 200 was the unexpected appearance of the introduced predator Cremifania nigrocellulata. How much this fly contributed to aphid reduction on exposed plots is unknown. According to funnel collections at the base of the tree, there were about 15 Laricobius larvae for every Cremifania larva, suggesting that Cremifania contributed only in a minor way to the total reduction. But, as C. nigrocellulata becomes more firmly established, its contribution to control can be expected to increase.

The tiny fly Aphidoletes thompsoni is another introduced predator that is rapidly spreading throughout the Willamette Pass area. Thus, unless relative effectiveness figures can be assigned to each of the various predator species (accounting also for interaction between species), it will no longer be possible to evaluate the amount of predation delivered by a single species.

Aphidoletes thompsoni (Diptera: Itonididae)

This predator -- established in six of seven release areas -- may eventually prove to be one of the most important predators introduced into the Pacific Northwest. The predator's main shortcoming is that it attacks too late in the spring to contribute much to the reduction of the first balsam woolly aphid generation. Also, A. thompsoni populations in the lowland droughty areas are detectably smaller than populations established at higher elevations. But even in the lowland areas, the predator has persisted and seems to be increasing in numbers each year.

The ability of A. thompsoni to exist at low prey densities is most encouraging, and apparently accounts for its survival at Black Rock when L. erichsonii failed. Another good feature of A. thompsoni is its good rate of dispersal: Measurements in 1962 at Willamette Pass, using collecting funnels nailed at the base of infested trees, showed a radius of spread starting at 875 feet in late spring, expanding to 1,535 feet in mid-summer, and finally reaching 2,135 feet in early fall. The total spread of 2,135 feet in the third year after release is some 700 feet further than the three-year dispersal of L. erichsonii in the same area.

To date there has been no formal assessment of the ability of A. thompsoni to reduce prey populations. But observations suggest that the predator might be very effective as a control agent. Many aphid-infested trees were observed to have heavy Aphidoletes populations continuously from mid-July to mid-October. Populations were particularly heavy in the aphid-infested Pacific silver fir stands of Randle and Cold Water Creek, Washington.

Other than a limited amount of predation by native neuropterons, notably by Hemerobius neadelphus Gurney, A. thompsoni appears to have few enemies in this region. Rearings of some 400 Aphidoletes adults from four areas in 1962 showed no sign of parasitism.

Cremifania nigrocellulata (Diptera: Chamaemyiidae)

This predator is established at Corvallis, Monroe, and Willamette Pass, Oregon. Status of colonies at the Willamette Valley localities of Monroe and Corvallis have changed little since last year's report. The predator is well distributed throughout the stands in both areas, but populations are seldom greater than two to three larvae per square foot of bark surface. This may be another instance of the dry soil conditions in the Willamette Valley reducing predator populations by affecting pupation.

It was surprising to find a large C. nigrocellulata population at Willamette Pass. Only one larva was found in 1961. In 1962, sizeable Cremifania populations were observed on nearly every aphid-infested tree within a 1,000 foot radius of the liberation point. On some trees, C. nigrocellulata larvae were quite abundant, numbering up to 10 per square foot.

A few C. nigrocellulata adults were reared from collections from each of the three established colonies. As yet there are no signs of parasitism, but it seems likely that parasites will find C. nigrocellulata. A native Cremifania species attacking Pineus (Hemiptera: Chermidae) is parasitized by an unknown chalcid. Checks will be intensified to determine if parasites become established on C. nigrocellulata.

Leucopis obscura (Diptera: Chamaemyiidae)

L. obscura is established in one locality -- Willamette Pass, Oregon. There, the predator has spread throughout the aphid-infested area. Although dispersal has been rapid, the insect has never been observed to be numerous.

Very little research has been done in Oregon on L. obscura. Accordingly, its value in controlling the balsam woolly aphid is unknown. Because of low populations and a tendency to avoid light aphid populations, it would seem that the control contribution is slight. However, since L. obscura often overwinters in various stages of larval development, it may be that the predator's most significant contribution is its feeding in early spring, just at the time the balsam woolly aphid is breaking hibernation. There are few other predators feeding at that time of year.

Pullus impexus (Coleoptera: Coccinellidae)

Until 1962, P. impexus had been liberated only once in the Pacific Northwest--in 1960 in a small farm woodlot near Monroe, Oregon. Observations in 1961 suggested that the population may have perished. However, examinations in the spring and summer of 1962 revealed the insect to be well distributed throughout the release area. On some trees the predator was very abundant; on others it was scarce.

There seemed to be little correlation between the abundance of the predator and the density of the prey population. P. impexus was found on trees with heavy aphid populations and on trees with prey densities averaging less than one aphid per square inch of bark surface. This ability to attack and survive at low prey densities, coupled with a predation period which starts early in the spring, suggests that P. impexus may become an important addition to the predator complex.

RECOLONIZATION IN 1962

There are many problems attendant with collecting predators in Europe and then shipping them for release in the Pacific Northwest. These problems, coupled with the one of colonizing predators in the widely scattered infested stands in the Pacific Northwest, has prompted some exploratory work on moving predators from one place to another within the region. The aim of tests in 1962 was to determine if predator recolonization is feasible and, if so, how it might be done most efficiently. L. erichsonii was the principal predator tested, although some collecting and mass rearing also was attempted with Aphidoletes thompsoni. Results of these tests follow.

Laricobius erichsonii

A total of 685 adults was obtained from established colonies within the region and reliberated in three areas in Oregon. One recolonization was made with naturally-emerged beetles, ready to mate and lay eggs immediately after release (like adults received from Europe). Beetles used for the other two recolonization attempts were reared from larvae that had completed feeding and were migrating to the soil to pupate.

Obtaining adults - The sexually mature adults for one recolonization were collected June 25 at Willamette Pass, just as they were emerging from winter hiberation. Two men spent 6 hours collecting the 126 adults. One collector searched the stems of aphid-infested trees and removed the predators individually with an asperator. The second man beat the beetles from the trees and collected them on a small, white sheet. It was decided that beating was more efficient and that more beetles could be collected if the sheet was large enough to completely cover the ground beneath the collecting trees. Adult L. erichsonii drop readily when disturbed; a sharp blow with an axe on even large trees will dislodge many beetles.

The 559 L. erichsonii adults for two other recolonizations were obtained by taking advantage of the beetle's habit of dropping to the soil for pupation. Plastic funnels to catch the falling, prepupal larvae were nailed to the bases of several aphid-infested trees at Willamette Pass, Oregon, and at Green River and Cold Water Creek, Washington (Figure 1). Each funnel emptied into either (1) a soil-filled clay pot which was subsequently used to rear adults, or (2) a water-filled fruit jar which served to determine the number of larvae being captured by each funnel. The pots were collected for rearing every 2 to 3 weeks; at the same time, the number of larvae were counted in the water-filled jars. Collections began in mid-July and extended to late August.

New adults began emerging from the pots placed in laboratory rearing, within 4 weeks after the first Laricobius larvae began to fall. On the basis of the number of larvae collected in water-filled jars (a maximum for one funnel of 174 larvae in 35 days), it was calculated that the number of beetles reared was roughly 25 percent less than the number which fell into the funnels. Because dead beetles were rarely found in the soil-filled pots after rearing was completed, it appears that most of the unaccounted 25 percent crawled out of the pots and pupated elsewhere, before the pots were picked up.

Liberation - The sexually mature beetles collected June 25 at Willamette Pass were liberated the next day in the Twin Lakes area, Umpqua National Forest. The liberation tree was a subalpine fir adjacent to the Twin Lakes Trail, about 1 mile north of where L. erichsonii was released in May. The beetles were quite active and started feeding immediately after liberation. In the hour that followed release, four pairs of beetles were noted mating. One month later, L. erichsonii larvae were observed abundant on the release tree. This area will be checked closely in 1963 to determine of a colony becomes established.

The first 204 adults reared in the laboratory were liberated August 21 on an aphid-infested subalpine fir adjacent to the Big Meadows Road, 1.1 miles north of the North Santiam Highway. The remaining 355 laboratory-reared adults were released on an infested subalpine fir adjacent to the McKenzie Pass Highway, 4.5 miles west of the Dee Wright Memorial. In both liberations, adult L. erichsonii were present on the release trees for a week or two and then disappeared. Presumably the beetles went to the soil for winter hibernation. Results of the two liberations should be apparent in the spring of 1963.

Aphidoletes thompsoni

Funnels were also used to collect Aphidoletes thompsoni, which, like L. erichsonii, pupates in the soil. This method was very effective for collecting prepupal Aphidoletes but the subsequent rearing attempts were not so successful. Based on the number of larvae that dropped into a water-filled jar at Randle, Washington, two other funnels emptying into clay pots on the same tree should have produced 1300 adults. Actually, only 233 adults, or 17 percent of the expected total, was reared. Other collections produced a somewhat higher percentage of adults, but not significantly so.

There is no clear explanation of why the rearings were unsatisfactory. It is believed, however, that the moisture level and type of soil in the rearing pots are very critical factors. It also appears that a significant number of larvae crawled out of the pots before pupation. Attempts to remedy both of these situations will be made in 1963.

Figure 1.--Example of plastic funnels used in the Laricobius erichsonii and Aphidoletes thompsoni recolonization experiments. Funnels in the photograph are attached to a Pineus-infested Engelmann spruce.

Because only a small number of A. thompsoni adults were reared (400 in total), no field liberations were made. Instead, the adults were confined in the laboratory with short log bolts cut from aphid-infested subalpine firs. Results of these tests showed that as few as 50 A. thompsoni adults (25 males and 25 females) will produce a sizeable larval population. Furthermore, the prey population on the logs remained in good condition long enough for the predators to reach the pupal stage. This suggests that one way to recolonize A. thompsoni would be to develop larval populations in the laboratory and then carry the logs to the field. However, an easier way might be to carry the collecting pots directly from the collecting area to the recolonization area and then cage the pots with aphid infestations on living trees. Both systems, as well as taking laboratory reared adults to the field, will be tried in 1963.

OBSERVATIONS ON OTHER PREDATORS

Six species of predators from India and Pakistan were introduced into the Pacific Northwest in 1961. Most died in rearing as described in last year's report; however, the status of two species was still in doubt at the time of writing. This section completes the information on those two predators: Chrysopa sp. II from India, and Exochomus lituratus Gorh. from Pakistan.

Chrysopa sp. II (Neuroptera: Chrysopidae)

On August 21, 1961, 29 adults and 34 eggs of Chrysopa II were caged on an aphid-infested subalpine fir at Mt. Hood, Oregon. Eggs, larvae, and pupae were noted when the cage was removed from the tree September 12, but there were no other signs of Chrysopa II during 1961.

Establishment checks were begun again in the spring of 1962. It was found that the release tree had died but that heavy aphid populations remained on two closely adjacent trees. Examinations were made on these trees throughout 1962, but the predator was never seen. It is believed that this colonization attempt failed. Nevertheless, establishment checks will continue to be made.

Exochomus lituratus (Coleoptera: Coccinellidae)

E. lituratus was first introduced in 1960. A liberation was made in the Santiam Pass area, but the colonization attempt apparently failed. In 1961, E. lituratus was again sent to the Pacific Northwest. This shipment of 55 adults was liberated in a laboratory cage containing logs infested with the balsam woolly aphid. As stated in last year's report, it was hoped that a population could be developed which would be attracted to the balsam woolly aphid.

When the report on the 1961 introductions was written, E. lituratus had already passed through one generation in the laboratory and had increased from 7 adults in September 1961 to 24 adults in February 1962. Since that time the population gradually declined in numbers until only three adults remained alive in October 1962. Then, there was a brief period of oviposition. Some 15 larvae developed but died in the late instars owing to declining host supply -- a supply which could not be replenished in time to save the population. Subsequently, the remaining three adults also died, ending the observations after some 19 months.

PROJECT PERSONNEL

Entomologist K. H. Wright, Division of Forest Insect Research, Pacific Northwest Forest and Range Experiment Station, was responsible for overall direction and coordination of the balsam woolly aphid project. Entomologist R. G. Mitchell was responsible for the detailed planning of the project, organization of the field and laboratory work, and reporting study results. Helping on the project on a part time basis during the summer was Biological Aid D. A. Barstow. M. C. Fenning, the Biological Aid who served as laboratory assistant for all projects at Sellwood, assisted part time in maintaining rearings.